
Space Weather Technical Forecast

Issued on Monday, 09 October 2023 at 13:29 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of isolated M-class flares. Slight chance G1 Minor Storm day 1-3 (09-11 Oct) from coronal hole fast winds. Chance G1-G2 Minor/Moderate storm intervals day 3-4 (11-12 Oct) due to CME arrival.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low with C7.6 flare observed peaking at 09/1143 UTC, from AR3451 in the northwest. There are nine sunspot regions visible. AR3451 in the northwest is the largest and most magnetically complex, with the development of delta spot. AR3460 in the southeast is the next most complex region, with ongoing growth and a delta spot possibly in its formative stages. The remaining regions are all smaller and simpler. No new Earth-directed CMEs have been detected.

Solar Wind / Geomagnetic Activity: Solar winds as observed at L1 by ACE/DSCOVR are indicative of generally Slow wind conditions, persisting at background speeds of 300-340 km/s for much of the period. A recent increase in the solar wind speeds to around 350km/s may be indicative of the early stages of a connection to a coronal hole high-speed stream. Density increased from average to above average levels, peaking at around 25 ppcc at 08/2154 UTC. Since 09/0500 UTC density has decreased, with a more substantial fall from 09/1000 UTC to below average values. Total interplanetary magnetic field (IMF) strength, Bt, has been weak, below 7nT. The north-south component, Bz, has been largely negative, ranging -6 nT to +7 nT. Phi angle was initially negative (toward the Sun) until 08/1800 UTC, then became generally positive (away from the Sun). Since 09/0700 UTC phi angle has varied between both sectors. Geomagnetic activity has been Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at background levels. GOES16 high energy (greater than 2MeV) electron flux was background to moderate, peaking 274 pfu at 08/1630 UTC. Associated 24-hour fluence was below the Active (1e8 integrated pfu) threshold. The observation at 09/0000 UTC was 5.16e6 integrated pfu.

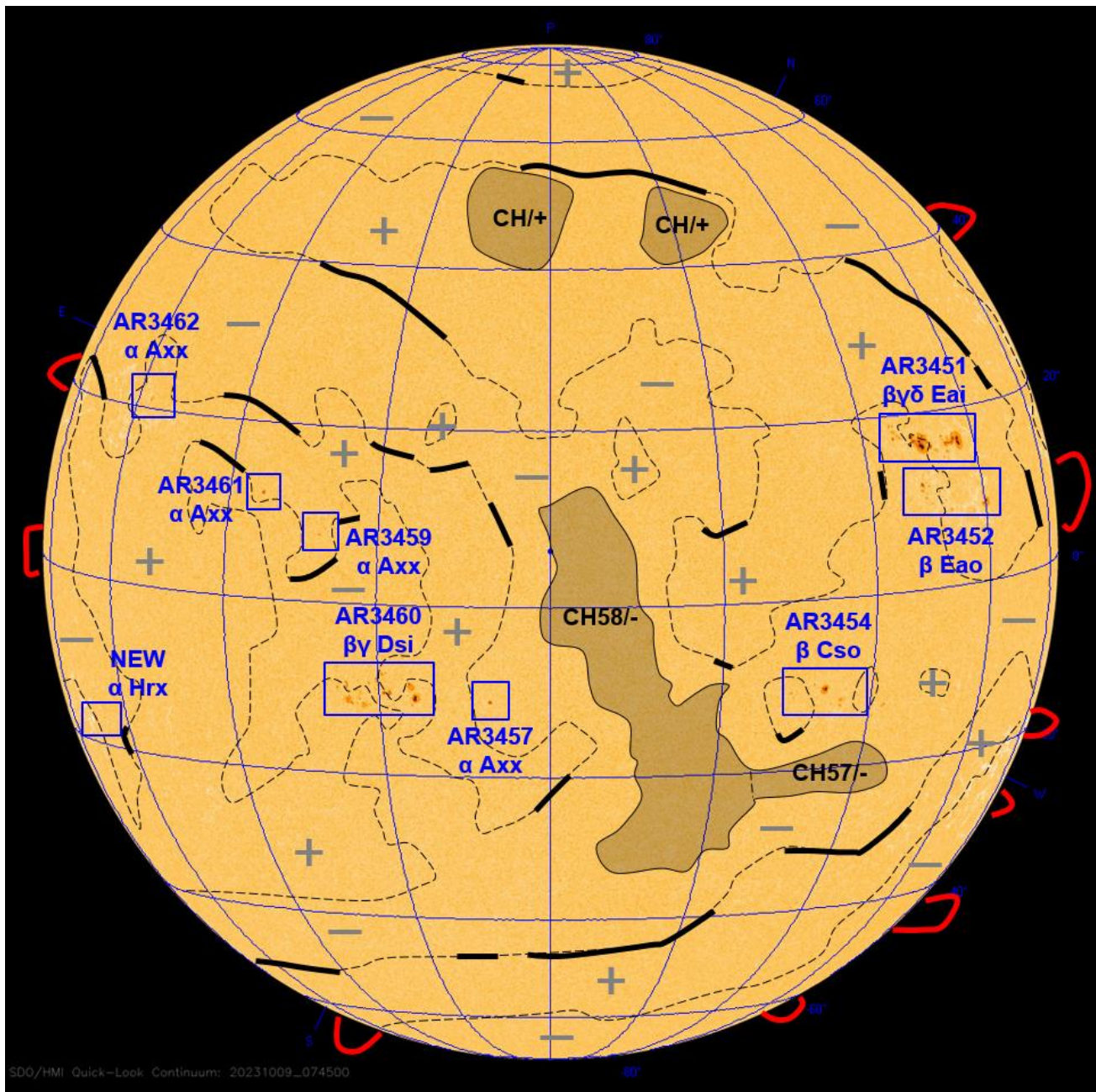
Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected with isolated M-flares likely. There is a slight chance of very isolated X-flare, most likely from AR3451.

Solar Wind / Geomagnetic Activity: There is one Earth-directed CME in the forecast, with expected arrival either late day 3 or early day 4 (11-12 Oct). Otherwise slow wind conditions are expected to give way to a transition into the fast winds of CH57/- during day 1, into day 2 (09-10 Oct) and then CH58/- later day 2 or day 3 (10-11 Oct). This will likely bring peak winds of around 500-600 km/s. Quiet geomagnetic activity will increase to Unsettled to Active on day 1 or day 2 (09-10 Oct) following the arrival of any CIR (co-rotating interactivity region) ahead of the fast wind enhancements, before easing again. Later day 3 or early day 4 (11-12 Oct), activity will likely become Active with a chance of G1-G2 Minor/Moderate storms intervals due to any CME arrival.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is most likely to remain at background levels, with a slight chance of enhancements, mainly if any notable flares from AR3451 occur. High energy electron flux (greater than 2MeV) is forecast to be at background to moderate levels throughout, dropping out with any fast wind or CME arrivals before potentially increasing again day 4 (12 Oct). Electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold.

Figure 1. Solar Analysis Valid 09/0745 UTC.



Key: Filament --- , Prominence --- , Magnetic Field Line --- , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

A CME associated with the C6.6 flare of AR3460 at 08/0339 UTC, is expected to arrive at Earth late day 3 or early day 4 (11-12 Oct).

Slow wind conditions are expected at first, but with Earth moving into the fast wind of CH57/- on day 1 (09 Oct) into day 2 (10 Oct). A transition is then expected later day 2 or early day 3 (10-11 Oct) into the broader high speed stream (HSS) from CH58/-. These fast winds are the expected to persist, likely at elevated levels of 500-600km/s, as supported by MOSWOC enlil, although this is currently considered too early with peak winds, most likely occurring on day 3 (11 Oct).

Quiet geomagnetic activity will increase to Unsettled to Active on day 1 or day 2 (09-10 Oct) following the arrival of any CIR (co-rotating interactivity region) ahead of the fast wind enhancements, before easing again. Negative coronal holes are less likely to give strong connections near the September equinox (Russell-McPherron effect) however there is still a chance of isolated G1 intervals. Later day 3 or early day 4 (11-12 Oct), activity will likely become Active with a chance of G1-G2 Minor/Moderate storms intervals due to any CME arrival.

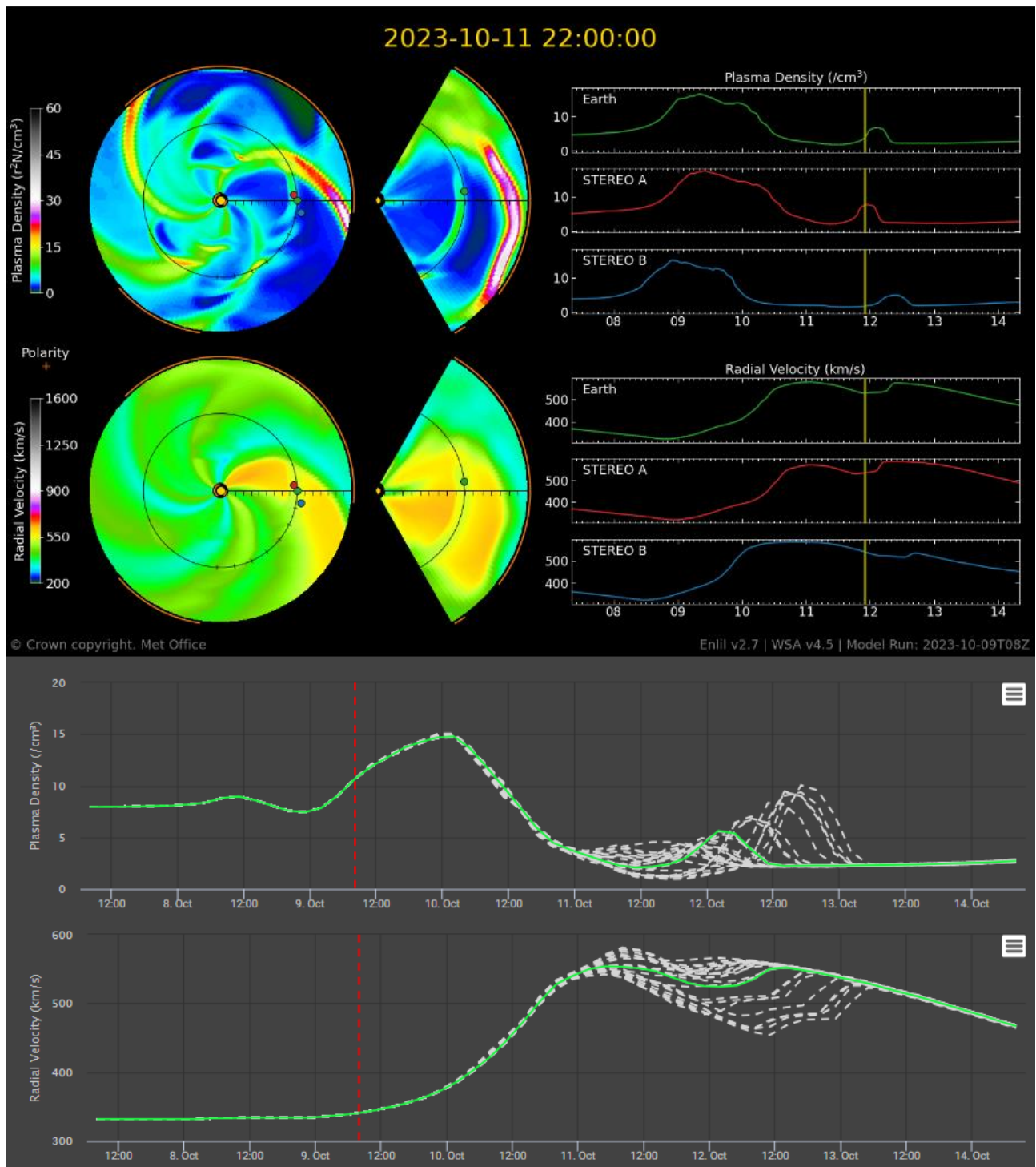
Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	10	20	30	30
Strong	G3	No	1	1	5	5
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
08/1435	Partial	C6.6 flare AR3460	SE	460 km/s	Late 11 or early 12 Oct	Arrival time very dependent on CH fast win arrivals.



Figure 2: Latest Enlil output showing fast wind onset and CME arrival, with ensemble



Radio Blackouts - X-Ray Flares:

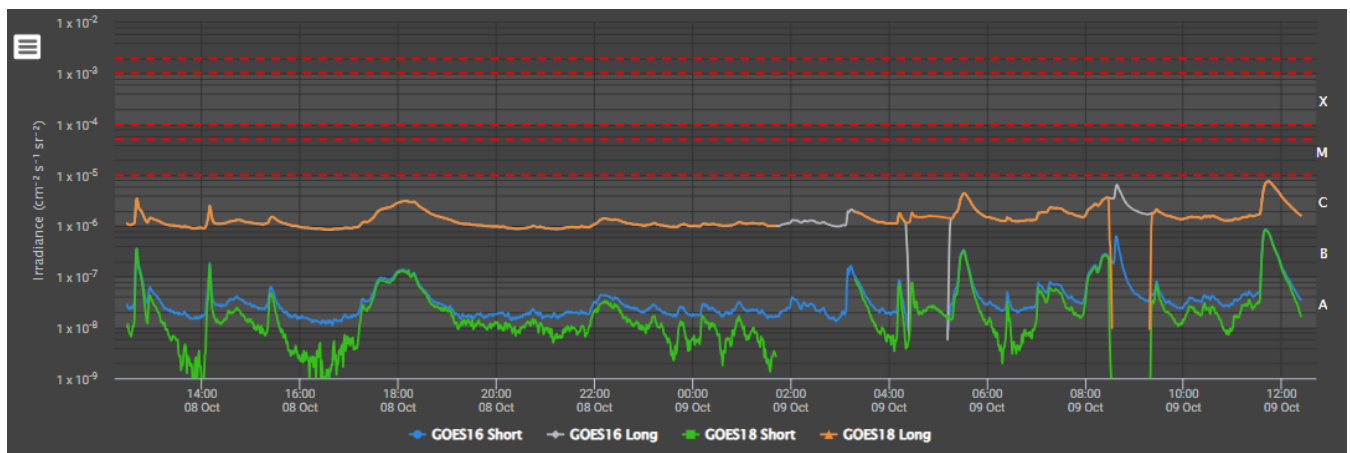
Solar Activity is forecast to be Low to Moderate with an ongoing chance of isolated M-class flares. There is a slight chance of activity increasing to High due to a very isolated X-class flare, most likely from AR3451.

Of the nine regions on the disc, AR3451 in the northwest is the largest and exhibits the greatest complexity. Over the last 24-36 hours a moderately sized spot has developed within this region, originally an intermediate spot but now the main trailer. This emerged near opposite polarity spots, resulting in a potentially unstable configuration with a delta-spot forming. A distinct north-south flux rope is also evident in SDO aia-211 imagery, with some s-shape curvature, connecting this spot to nearby AR3452, a weaker spot to the south of AR3451. Overall, this suggests an increased likelihood of M-flares, and a slight chance of X-flares.

AR3460 is a smaller region in the southeast. The delta spot previously evident has decayed, however, recent images suggest that a new delta spot is currently forming in the trailer portion of the group, along with the emergence of further small spots of mixed polarity. Its complexity does suggest the potential for significant flaring, especially if any further growth occurs. The other regions on the disc are currently smaller and simpler.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	60	55	50
Very Active	R3 to R5 X Class	No	10	10	5	5

Figure 3: GOES16/18 X-ray flux



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is most likely to persist at background levels. AR3451 has developed a small delta spot however, and given its location on the northwest disc, this brings an increased potential for proton flux to rise should any notable flares occur from this region.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	10	10	10	10
Very Active	$\geq \text{S3}$ *	No	1	1	1	1

* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)

High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy electron flux (greater than 2MeV) as observed by GOES16 has achieved moderate levels at the diurnal maximum in recent days. This is expected to continue through the period, with a slight chance of briefly reaching High levels during the diurnal max. The potential HSS arrivals from day 1 until day 3 (09-11 Oct) could potentially bring a suppression in the flux, before a further increase is likely later in the period. This most likely by the end of day 4 (12 Oct).

Electron fluence is forecast to be well below the Active ($1\text{e}8$ integrated pfu) level throughout. MOSWOC REFM output is currently giving good guidance.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	1	5	10
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1



Figure 4: GOES16 >2MeV Electron Flux and Fluence with REFM

